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# METHODOLOGICAL AND TECHNOLOGICAL INNOVATIONS IN THE AREAS OF DEMOGRAPHIC DATA COLLECTION, PROCESSING AND ANALYSIS

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# METHODOLOGICAL AND TECHNOLOGICAL INNOVATIONS IN THE AREAS OF DEMOGRAPHIC DATA COLLECTION, PROCESSING AND ANALYSIS

## I INTRODUCTION

1. Demographic data describe the structure, distribution and growth potential of country's population at any given point in time. Thus, they constitute an essential tool for planning, monitoring and evaluating the socio-economic development activities undertaken by a government. The information is also useful in research work and in forecasting business trends.

2. Population censuses, demographic surveys and civil registration systems are the main sources of demographic data although in a few countries such data can be compiled from population registers.

3. Whatever the source of data, their usefulness is enhanced to the extent that they are relevant, timely and accurate.

4. It is recognized, though, that any large data collection exercise cannot be error-free. Every effort, however, needs to be made at the various stages of their collection and compilation to anticipate the types and varieties of deficiencies and to take measures to ensure generally acceptable quality. Further, the data have to be evaluated, analysed and disseminated within a relatively short time after their collection to ensure their effective and extensive applications.

5. There have therefore been continuing efforts to develop strategies and improve on methods and techniques for the collection, processing, evaluation, analysis and dissemination of demographic data to ensure that they satisfy the data needs of various users in terms of their relevance, accuracy and timeliness.

6. The paper attempts a review of some of the major methodological and technological innovations in the fields of population censuses and demographic surveys which are the principal sources of demographic data in the African region.

7. The discussion is divided into three parts. The first part deals with developments in the area of data collection including census/survey cartography, the second focuses on computer processing while the third part is devoted to data evaluation, analysis and dissemination.

## II COLLECTION OF DEMOGRAPHIC DATA

8. As indicated earlier, censuses and surveys are two of the main sources of demographic data. Indeed, in most African countries they constitute the only sources since civil registration systems are generally incomplete and in most cases deficient.

9. A population census has been defined in the UNited Nations publication: Principles and Recommendations for Population and Housing Censuses as the "total process of collecting, compiling, evaluating, analysing and publishing or otherwise disseminating demographic, economic and social data pertaining, at a specified time, to all persons in a country or in a well-delimited part of a country".

10. As can be seen from Annex I, with the exception of Chad, all African countries have conducted at least one population census and for some of the countries- Egypt, Gambia, Ghana, Lesotho, Mauritius, Seychelles and Swaziland - the history of their censuses dates back to the 19th century.

11. There are two principal methods for the collection of data in a census. These are the direct interview or canvasser method and self-enumeration or householder method. Most countries in the African region have used the former method in their recent censuses. The method involve the use of trained enumerators who move from house-to-house to administer a standardized questionnaire.

12. Although censuses constitute a major source of demographic data, they are conducted infrequently-generally at ten-year intervals - hence demographic surveys are increasingly becoming the widely used method of demographic data collection in Africa. The basic difference between a population census and a demographic survey is that the former involves total coverage while the latter involves the convassing of a sample of the population. The selection of samples for demographic surveys is usually based on probability methods which enable researchers and statisticians to make required inferences.

13. A demographic survey can either be specialized, in the sense that only demographic information is collected, or generalized, in which case demographic items form only part of the information collected.

14. Both types of surveys have been conducted in the African region. The surveys conducted in the region may also be classified into two main groups namely, those conducted under continuing survey programmes and ad hoc surveys.

15. The most critical phase of a census or survey is the stage for the collection of information from the population. The types of problems faced and procedures used for the collection of data are similar for censuses and surveys hence innovations in procedures in both sources of data are discussed together in this paper. The discussion focuses on the following strategies for the collection of data: questionnaire design including provisions for dealing with situations where two or more languages are used in a country, audio-visual training of field staff, quality control of enumeration/interviewing through use of field editors, use of micro-computers for data collection and census cartography.

A. Questionnaire Design:

16. In Africa, as in other developing countries, collection of demographic data either through surveys or censuses is usually done on standardized questionnaire/schedule appropriately designed to assist both respondents and enumerators in accurately providing and recording the required information. It is important to mention that questionnaire design is one area in the whole spectrum of survey design that is always experiencing changes aimed at improving its efficiency and effectiveness.

17. Recent improvements and/or changes have included increasing use of verbatim questions; pre-coding of responses and use of multi-lingual questionnaires, as well as use of computer in questionnaire design. Each of these is briefly discussed below.

(a) Verbatim questions:

18. It can be appreciated that control of answer recording in a situation like population census, where hundreds of interviewers and thousands of respondents are involved, will be difficult to achieve. The problem is even more pronounced in questions that concern opinions and attitudes of respondents.

19. The problem can partially be solved by use of verbatim questions which, in effect, require that an enumerator read a complete question to a respondent. Experience gained, so far, indicate that the method, if properly applied, ensures uniformity of data between different enumerators and respondents.

(b) Pre-coding:

20. Closely associated with the use of verbatim questions in questionnaire design is the pre-coding of response categories. This technique involves the provision of a list of responses, in most cases obtained from similar surveys/censuses carried out in the past, and respondents requested to choose among the

alternatives. The responses are pre-coded and enumerators are required merely to mark a box, encircle a code, underline printed alternatives, etc.

21. It is not uncommon, these days, to find questionnaires which are totally pre-coded. Advantages, so far, observed with the procedure include:

- Reduction of errors that may be introduced during office coding.

- Respondents and enumerators have an opportunity of choosing an answer from alternatives given.

- Reduction in time needed for data processing due to elimination of office coding.

(c) Multi-lingual questionnaires:

22. It has been observed, especially in developing countries where two or more languages are used, that misunderstanding and introduction of unnecessary errors are common when the language of questionnaires is different from the language of interview.

23. Current solution to the problem entails translation of census/survey questionnaires into as many languages as can practically be done and utilization of interviewers who understand and preferably use the local language. It may be recalled that the World Fertility Survey (WFS) in which a number of African countries participated, effectively used, wherever that was possible, multi-lingual questionnaires. Also, it need be mentioned that the idea had earlier been attempted in Ghana during its 1960 population census when translations of the census questionnaire in the major languages were included in the Enumerator's Manual. Of course, there are numerous operational and logistical problems associated with the use of multi-lingual questionnaires. The method, however, has a noticeable advantage and it need not increase significantly total cost of questionnaire development.

(d) Use of computer in questionnaire design:

24. In designing a questionnaire, the objectives to be achieved are readability, simplicity, good appearance and processability. Appropriate microcomputer softwares have become useful tools to accomplish these objectives.

25. A number of word processing packages can be used to design questionnaires. Indeed they allow users to type documents, modify them on screen, print in appropriate formats and save the documents

on disk for later use or additional editing. Other packages contain specific features such as multicolumn format, variable spacing horizontal scrolling and block copy functions.

26. To produce a well designed questionnaire, a word processing package must contain features for printing in a variety of styles and sizes. The use of a laser printer would permit production of high quality questionnaires. The following packages can be used for designing a questionnaire: multimate, word, word perfect, ESP, GRIDS, XYwrite and Framework.

B. Audio-Visual Training of Field staff

27. It has been, and still is, the usual practice to give lectures, assign exercises, and hold mock interviews during training sessions for enumerators and supervisors in preparation for major data collection exercises.

28. The procedure, though effective, has some weaknesses. Particularly, in the training of census field staff, the simulteneous training sessions spread over many training centres and involving use of a large number of trainers may result in training programmes of varying standards.

29. Audio Visual training, particularly through recorded training programmes on video-casettes and a country's television network has been recognized as a useful strategy to ensure standardization in the training of census/survey field staff. However, such a strategy involves high costs which presently many developing countries can least afford.

C. Quality control :

30. Introduction of quality control procedures at all levels of census/survey activities is essential if data are to be of acceptable accuracy. The case is even more crucial in population censuses, in view of the involvement of large numbers of respondents and enumerators.

31. It has been observed that quality control is, sometimes, not given adequate attention in African censuses. Generally, the quality control measures, adopted in many developing countries, involve: the recruitment of appropriate enumerators and use of a high supervisor/enumerator ratio. These, however, do not cover the total arena of census/survey quality control activities. It is necessary to note that a continuous and widespread application of quality control procedures should, wherever possible, be enforced at all stages of data collection exercise.

32. Recent development, in the continuous effort to improve quality of data, have included: use of competent editors at the field level and use of tape recorders during enumeration/interviewing.

(a) Field Editors:

33. Deployment of editors to review and edit questionnaires at the field level has proved effective in controlling the quality of work at the data collection phase of censuses/surveys. The procedure assists in detection of simple errors, like ommissions, duplications, inconsistencies etc., at an early stage and therefore allowing for early remedial action. Needless to mention that the method reduces to a minimum, and in some cases eliminates, the problem of referring questionnaires back to the field .

(b) Tape Recording :

34. In an effort to intensify supervision, some countries are now providing enumerators with tape-recorders which they use in recording a selected number of their interviews. The taped interviews are forwarded to supervisors and/or survey planners who use them to assess competence of individual enumerators in handling respondents and cross check responses recorded on questionnaires against interview responses. The method is, however, costly and time consuming.

D. Computer-assisted Interview

35. The initial use of computer in census and survey programmes had been in the editing of data and the production of relevant statistical tables. Subsequent developments in hardware and software, however, have broadened the scope of computer processing and made it possible to use the computer for all phases of data processing from data entry to the presentation of the required tables for publication. Indeed the computer is also used for office automation including questionnaire design and desktop publishing.

36. Such developments together with technical advances in microcomputer technology in turn made computer-assisted interview a feasible proposition in the collection of data. Indeed, the develoment of 'lap-top' computers and appropriate computer-assisted interview packages opened up the possibility of an interviewer using a computer-based questionnaire and coding instructions to conduct an interview and thus eliminating the use of a separate office coder.

37. Initially, computer-assisted interview software packages were developed for use in situations where interviews are to be conducted by telephone. The recent advances which have increased the storage capacity of micro computers have, however, opened up the possibility of using computer-assisted interview packages in field interviewing. The strategy involves an interviewer entering codes of responses directly into a portable microcomputer and any necessary consistency checks carried out. The data are then periodically transferred to a larger computer system for further processing. It should be pointed out, though, that if a microcomputer is to be used for data collection then its storage capacity should be able to store:

- programs which control the interview
- relevant codes lists and coding frames; and
- reasonable number of sets of [illegible]

38. Advantages of the strategy include increased ability to check and correct inconsistencies at the time of interview or shortly thereafter and significant reduction in processing time. The approach, however, means providing each interviewer with a micro computer and the related cost, maintenance problems and higher risk of loss of the equipment do not make the strategy a viable approach, at present, in the collection of data in censuses and large-scale surveys, particularly in African countries.

E. Developments in Census Cartography

39. In terms of methodology and technology, census cartography has made considerable progress over the last five years. This has been made possible by placing in orbit satellites such as Landsat Thematic Mapper (TM) and Spot which produce high-resolution images and make it possible to observe land use on a constant basis. Another reason for such progress is the advances in microcomputer technology.

(a) Satellite imagery

40. The great advances in remote sensing technology, (Landsat TM and Spot Satellite) have made it possible to produce images of very high resolution (up to 10 meters in panchromatic) which have been effectively used to up-date basic maps of rural areas where land use changes frequently and town plans, particularly of those metropolitan areas having a very high rate of population growth and changes in the urban network.

41. In this regard, note should be taken of the new area sampling technique by which a team of ORSTOM research fellows recently used satellite images to conduct demographic surveys in the French town of Marseille and the town of Quito in Ecuador.

42. The method developed used a two-stage stratified sampling here: the morphology of the towns were stratified according to density taking into account the height and position of buildings; delineation and selection of first-stage units (blocks) by systematic use of point gradation technique; and selection of second-stage units consisting of households. The satellite imagery is used to:

(i) Define the sampling base (universe);

(ii) stratify the sampling base according to the density of built-up structures and;

(iii) the selection of sampling blocks.

43. The Equipment needed to carry out this methodology consist of:

- an IBM-AT/PS-2 micro-computer or compatible;
- a printer;
- a software package for survey data entry and processing (eg: IMPS);
- a software package for processing satellite images on PC (eg: TIMOR-developed by ORSTOM);
- a compass, a clinometer, a decameter and a manual planimeter).

44. There is still room for improvement in this method in particular through the morphological stratification of satellite images which takes into account the height and the dispersion of the houses.

45. In conclusion it could be said that, in view of its cost, accuracy and the limited equipment needed, this method is relevant and in the collection of demographic data in major towns where characteristics change rapidly and which don't have comprehensive and up-to-date sampling frame.

(b) Micro-computers

46. Micro-computers have also revolutionized census cartography. Indeed, they have made it possible, through a completely or partly automatic process to prepare thematic maps and graphics for visualizing, storing and managing demographic data.

47. Among the new portable and high-performance equipment available mention can be made of (in addition to the central memory of the PC itself) the digitization tablet for data entry and the dot matrix colour and laser printers as well as the tracing tables or glides which serve as output devices.

48. There are also many software packages which combine data tabulation and data import/export modules with ASCII and DIF indices (e.g. Freelance, Atlas Grapics, etc.).

49. It would therefore seem that all is set for the automatic building and management of geo-demographic data banks. This would greatly lighten the long and arduous task of census cartographers in the publishing of collected data, the filing of cartographic products and the continual up-dating of the sampling frame during the intercensal period.

## III. COMPUTER PROCESSING

50. The pace at which changes are occurring in computer technology has increased spectacularly in recent years and the most marked change today is the shift to the use of micro-computers to process survey and census data.

51. The successful use of micro-computers for large-scale statistical computing with the manipulation of extensive and voluminous data is now guaranteed by powerful software packages and the increasing storage capacity provided by peripheral disk units.

52. This explosion in micro-computer technology has even made it possible, local conditions permitting, to process data in a decentralized manner.

53. A number of initiatives have been taken in the various phases of data processing. An attempt will be made to characterize each of them with particular reference to the data entry, data editing and tabulation phases within the context of an integrated programme.

### A. Data Entry

#### (a) Equipment

54. Data entry is the first phase of computer processing and consists of transferring information from questionnaires on to computers. This can be done when appropriate hardware and software are available and the staff who would operate them during this phase have been adequately trained.

55. The data entry equipment used in recent years generally comprise work stations hooked up to mini-computer terminals. Currently there has been a shift towards a systematic use of micro-computers. The experiments conducted with micro-computers have all been satisfactory and all the more so because of the increasingly

high performance of the software available today. Because of the requirements of certain software packages, the selection of hardware for data entry is increasingly shifting to those having hard-disk components.

56. Commercial products have been placed on the market but they are expensive and protected. Examples are Entry Point and Rode/PC. Other software not rating as high in performance are distributed free of charge. Examples are PCEDIT, ISSA, IMPS, the last two of which are particularly recommended because of the possibilities they offer for creating data dictionaries. IMPS, however, requires the use of a Realia Cobol compiler.

57. In determining the size of a data entry work station, account should be taken not only of such parameters as volume of data, operator performances and verification rate but also factors relating to local conditions. In addition to all this, the fact that electricity supply is unpredictable and has adverse effects on computer equipment makes the procurement of current regulators, uninterruptible power supplies and generators necessary.

58. The power of software and the easy programming they provide have simplified controlled data capture which is the general practice nowadays. Simultaneously with data entry validity tests are conducted on range, likelihood, consistency and structure of the data keyed. In order to avoid a slow-down of data capture resulting from recourse to a supervisor when inconsistency is detected, it is advisable to limit the number and nature of such tests.

(b) Monitoring

59. Each working day, the output and performance of operators should be recorded and periodically reviewed in order to ascertain that data entry is proceeding according to schedule. The data entry software packages mentioned earlier come with features for generating statistics on operators. They should therefore be used judiciously.

(c) Decentralized approach

60. As indicated earlier, the proliferation of increasingly high-performance and low-cost micro-computers has made it possible to foresee the decentralization of data entry, if not the entire phase of data processing. It will not be easy, however, to implement such an approach because the following conditions must be fulfilled if things are to go smoothly.

- The degree of decentralization must be worked out judiciously;

- the equipment and staffing required and their costs must be accurately estimated; and

- the training of personnel should be accompanied with equal strictness in the enforcement of instructions and working methods.

B. Data Editing

61. The purpose of data editig is to achieve comprehensiveness in all the data entered and to make sure that there is no duplication of effort. It also ensures that the data are consistent and accurate.

62. A comprehensive computer programme should be prepared to that end. To do this, the experts involved in the operation should jointly prepare the edit specifications in a logical manner which avoids redundancy in correction procedures. The methods for correcting errors should involve two types of procedure: procedures for determining the variables to be corrected and procedures for deterministic or random imputation.

63. The software programme mostly used at this stage is the CONCOR module of IMPS.

64. It is advisable to set up a manual control system that allows for checking the corrections made by the programme. Such a system may involve comparing the basic tables generated from the data sheets before and after the editing exercise.

C. Tabulation

65. The tabulation plan prepared by systems analysts should take into account the software to be used and should contain defining elements on the basis of which programmes can be prepared. For a given table, the target population should be indicated together with the selection criteria, geographical levels and other indications.

66. The tabulation software most often used is the CENTS module of IMPS.

67. Tables may be produced as and when data are keyed and verified. Results may also be presented in graphic form using appropriate packages such as Harvard, Chart, Freelance, etc.

68. For the preparation of final reports, desktop publishing software such as Ventura and Pagemaker could be used.

## IV. EVALUATION, ANALYSIS AND DISSEMINATION OF DATA

69. The role of the demographer/analyst in the evaluation and analysis of population census and demographic survey is very crucial. Several methodological and technological tools have been made available to lighten the burden of the analysts and to expedite publication. Some of these innovations are highlighted below.

### A. Methodological Innovations

#### (a) Evaluation and adjustment of data

70. There are several methodolocial innovations available for improvement of the quality of an information from the stage of preparations for data collection to the compilation of the data. Also there are techniques for the evaluation and adjustment of the data when once the types and magnitudes of errors and biases are delineated.

71. At the stage of preparations for data collection and during field operations, in addition to proper planning and making arrangements for publicity and education, there are quality control measures which can be instituted to assure data quality. Again, at the data compilation stage adequate supervision and quality checks can be enforced to vouch safe better quality of data and at least to safequard against further deterioration of data quality.

72. Yet inspite of all precautions, some deficiencies may persist in the data which then will have to be evaluated and adjusted.

73. It has been demonstrated that a well designed and conducted sample survey can throw detailed light on demographic parameters as illustrated by the World Fertility surveys (WFS), the Demographic and Health Surveys (DHS), the African Household Capability Programme Surveys (AHSCP), the Contraceptive prevalence surveys (CPC), the Living Standards Measurement Studies (LSMS) and the Social Dimension of Adjustment project (SDA) and the series of migration surveys conducted in the ESCAP region. A large volume of technical publications and documentation are available highlighting the use of such surveys in developing countries. Even though a few African countries have participated in the fertility, health, contraceptive prevalence, living standards and household surveys and their experiences are adequately documented, not much effort has been made to exploit fully and systematically these

methodological tools. These surveys in addition to transferring new methods and technologies also strive to build institutions through active collaboration in data collection, analysis and research and endeavour to bring together data users and producers at national level and, to a certain extent, also engender international collaboration and exchange of experiences.

74. The data situation in Africa has improved tremendously in the last decade thanks to the African census and survey programmes and several special surveys assisted by international agencies. African censuses have been quite comprehensive and have included demographic variables and socio-economic, geographic, household and housing information. Since other sources of information are lacking or deficient, censuses have become the major avenue for demographic data and hence most countries collected various types of basic demographic data. Annex II gives the demographic information collected during the 1980 round (1975-84) of censuses. In addition, most countries included questions bearing on education, economic activity, physical status or disability, household and housing characteristics and even community level variables.

75. For instance, during the 1980 round of censuses, all the countries collected information on age, sex and relationship of members of households. Marital status, place of birth and ethnic/tribe/nationality information was collected in 43 of the 47 countries. Data on children ever born and on recent birth or birth last year was included in 33 countries whereas the number of living or dead children and residence status of individual members were enquired only in 32 countries. Duration of residence was obtained in 21 countries and survival status of recent/last birth and residence at specified time in past was canvassed in 20 countries. Another item included in 18 countries pertained to deaths in households. Even though there were several other types of basic demographic information collected, only a few of the countries collected such data. On the whole, it can be said that these information will enable an analyst to study population dynamics.

76. With the wider availability of data for most countries in the region it has now become possible to apply methods and techniques which could not be operationalised in the past. For instance, single year of age data is now available for all the countries and in most cases at sub-national and other small area levels. Thus, it is possible to study digit preference and other types of errors and biases and to discern the appropriate grouping or other manipulation of data to minimise the biases. Also more specific techniques like the Preference Pattern Index (PPI) can be easily applied to data to delineate the pattern and intensity of digit preference errors in the context of varying age composition as for rural/urban population distributions oand those generally affected

by migration like sub-national or other small area populations. The PPI takes care of age-sex composition of population and hence is preferable to the Myers Index (MI) although it is similar to the MI requiring the calculation of 10 matrices starting with end digits 0,1,...,9 for each sex usually in the age ranges 10-69. However, whereas the MI deals with the actual observed numbers, the PPI uses percentages in each of the ages to the total in the group... Not many countries have utilised the PPI in their data analysis but wherever it has been applied, it has thrown much more light on the quality of single year data than the usually applied Digit preference index originally developed by the US Bureau of the Census, the Whipples, Myers, and Bachis indices. Even though the computation of PPI requires more effort than the other indices, the use of computers and appropriate programmes or use of Lotus spread sheets can lighten the work.

77. Noting the fact that digit preference errors vitiate even grouped data, the need for evolving tests for data quality has become imminent. For instance, the Age ratio defined by the UN as the ratio of the population of a given age group to the average population in the adjacent two ages has been shown to be affected by the preponderent preferences for specific end digits in age reporting. However, this can easily be taken care of by defining the age ratio as the ratio of population in an age group to the weighted average of population in the three age groups including the two adjacent as well as the age group under consideration. The weights suggested are 2 for the mid-age group and 1 each for the neighbouring ages. This method not only removes the effect of digit preference errors, it also ensures that deviations of these ratios from the expected value of unity is minimal and takes into account, to a large extent, the curvilinearity of the age distribution. The age ratio score can then be defined as usual.

78. Another modification suggested in the evaluation of data is in regard to calculation of sex ratio scores. Since the UN method tacitly assumes that the sex ratios are constant over the age range, it has been observed that the score obtained may not reflect the data quality. It seems better to define the deviations of sex ratios as one half of the second differences of consecutive sex ratios instead of the first differences. The sex ratio score then is defined as the average of these absolute differences.

79. The UN defined a composite index of data quality as the sum of age ratio scores for males and females and three times the sex ratio score. The rationale for higher weight for the sex ratio score is that it is much less variable than age ratios and hence has a better predictive value. A value of the score less than 20 indicates acceptable quality of data. An index between 20 and 40 denotes inaccurate data and a value above 40 means that the data

are grossly deficient. There is need to re-examine the UN Joint Score especially in regard to the weight given to the sex ratio score and the classification of data as acceptable or otherwise in view of the large amount of single year and grouped data available for several points of time for developing and developed countries and the observation that both the age ratio and sex ratio methods have been suggested to need modification to reflect African data situations. Perhaps the application of multivariate techniques like discriminant or classificatory analysis may be tried.

80. In addition to the above vertical and horizontal consistency checks based respectively on age and sex ratio scores, it is now possible to test diagonal consistency of data in a large number of African countries because of the availability of more than one census data. The survival ratios - both cohort and overall - can be fruitfully employed to study not only consistency between two census enumerations but also for calculation of life tables. Some methods for deriving the parameters of population change - fertility, mortality and migration - will be indicated later. But a simple yet powerful method based on two censuses taken at intervals of 10 years which is unfortunately not so widely known is that suggested by Hardy. In this method the crude death rate during the intercensal interval is estimated as:

$$D = 0.4(P_{0+} - P'_{10+})/(P'_{0+} + P_{0+})$$ where

$P'_{x+}$ and $P_{x+}$ are respective populations ages x years and over at the second and first censuses. The crude birth rate can then be estimated as the difference between the natural growth and crude death rate. Estimate of life expectation can then be matched with a suitable stable population model with these vital parameters. The assumption involved is that the population is not affected by migration and that the two enumerations are ofsimilar magnitude of coverage. This method can also be utilised as an evaluative tool for coverage of the younger ages.

81. There are also several other consistency checks possible based on age-sex data through the calculation of various types of rates and ratios like child woman ratio, dependency ratio etc. which can then be compared with either suitable model populations or with another country having similar demographic situations.

82. Yet another novel avenue for data evaluation is through the channel of consistency-convergency criteria. In these procedures, the enumerated age-sex data are manipulated analytically to derive vital parameters and these are then compared with known values and with themselves. The forward and backward projection techniques

which can easily be carried out by using available computer packages are powerful tools in this exercise. A few other techniques will be indicated while discussing analysis of data.

83. The availability of a variety of model populations, the improved data situation in the region and the accessibility to the computer has made the problem of operationalising some of the above methods rather easy.

84. Once the types and magnitudes of errors are delineated, the problem of adjusting the data will remain. Several methods based on mathematical, demographic or analogy are available. It seems that a combination of mathematical and demographic methods may be most suited to countries in Africa. In this connection, the method proposed in the UN Manual X (Indirect techniques for demographic estimation, New York, 1983) utilising the available age-sex data in conjunction with population models and a mathematical curve looks promising. Most of these methods can be carried through with the aid of spreadsheets.

85. Application of some of the above ideas to some African data are illustrated in a recent publication of the ECA which is based on a training workshop held at RIPS, Ghana. (Workbook on demographic data evaluation and analysis, 1989).

(b) Data analysis

86. A serious lacuna in developing countries in general and African countries in particular is the lack of direct information on the dynamics of popualtion change. Indirect questions bearing on fertility, mortality and migration are usually the only avenues available to arrive at the level, trend, pattern and differentials of these vital parameters. Several techniques based on reported age-sex data also are available.

87. The original methods developed by Brass for the estimation of fertility and mortality have been modified and fine tuned to reflect both data availability and the fact that some of the assumptions may no longer be applicable.

(c) Fertility analysis

88. The Brass relational Gompertz model using parity and cumulated fertility based on one and two census data and the Zlotnik-Hill method for hypothetical cohorts have been noted to be useful in the estimation of fertility in African coutnries, using the indirect questions bearing on fertility.

89. Based on age-sex data from one and two censuses, the reverse and forward survival methods and its variations like the survival ratio methods for five year age groups and cumulated populations by age; the UN Manual IV method using age-sex distribution and a life table or growth rate/gross reproduction rate; the Coale method using C(15) - population under age 15 for both sexes- , an estimate of 1(5)- the life table population at exact age 5 with a radix of unity-and an intercensal rate of growth; the Preston-Coale equation using C(15), intercensal age specific rates of growth and 1(5) and the Preston integrated method for two census age -sex data are some of the methods which have been found to be robust under the existing conditions in the region. More and more methods are now being evolved to estimate demographic parameters from the important information collected in every census or survey, viz., the age-sex data. In this connection an elegant method based on the reverse survival ratio technique proposed by Venkatacharya and Tesfay recently to estimate birth rate from an age distribution, a growth rate and value of 1(5) deserves mention here. By this method the birth rate:

$$b = C(15)\ \mathrm{Exp}\ (7.5\ r) / [\ .365 + 14.6\ 1\ (5)\ ]$$

where c(15) is the cumulated proportion up to age 15 for both sexes, r is the growth rate and 1(5) is the life table population at exact age 5 for a radix = 1.

90. This estimate is equal to that from the well known reverse survival ratio method of obtaining birth rate from population enumerated under age 15 and is simpler than the equation given by Coale for a robust estimate for a stable population in that one does not need to assume stability of the population. Illustrations of these techniques to African data are given in the ECA Workbook mentioned earlier.

(d) Mortality analysis

91. For the estimation of mortality utilising indirect questions on survival of respondents the Brass child survival method and its modifications by Trussel and Sullivan and further adaptation given in the UN Manual X and the estimation of intercensal mortality by using hypothetical cohorts as elaborated by Zlotnik and Hill are found to be suited to data situations in the region. For adult mortality the maternal orphanhood data seems more suitable under the existing situation in African countries.

92. Based on one or two census age-sex data there are several methods which could fruitfully be employed to arrive at mortality estimates. For instance, the Hardy method and the Manual IV method already referred to for estimation of fertility also produces estimates of mortality. The Arriaga, Stolnitz and Coale-Hoover methods also could be applied when age-sex data from one census and an estimate of growth rate is available. When two census age-sex data are available one can try the Carrier-Hobcraft, the Coale-Demeny projection and cumulation and the Preston - Bennette methods. The ECA Workbook referred to earlier has illustrated the application of these techniques to some African data.

93. Unfortunately some of these methods have not yet been prepared for micro computers and hence ready made softwares are not available. However, for most of them the main frame version programmes are already available. The Regional Institute for Population Studies has prepared programmes for the methods illustrated in the ECA Workbook and micro computer versions are being explored. Most of these techniques however can easily be operationalised by use of spread sheets.

(e) Migration analysis

94. For the estimation of migration, questions on place of usual residence, place of birth, duration of residence in place of enumeration and place of residence at a specified time or certain number of years ago which are canvassed in most of the countries could be utilised especially if they are cross tabulated by age, sex and meaningful geographic areas. The census survival and life table survival ratio methods are useful tools in estimating migration when age-sex data are available at two points in time. The forward, backward and average survival estimates could be used to estimate migration depending on the information on the pattern of migration over the intercensal interval. The Lotus spread sheet method or the POPSYN programme (NETMIG) could be employed in these exercises. Population projection (forward and backward) programmes available in several micro computer packages could also be fruitfully employed in estimating migration by the survival ratio methods.

(f) Some observations

95. There are several softwares for microcomputers like the UN Mortpak lite, the East West Institutes EASWESPOP, and the POPSYN recently introduced by the Garcia-Bogue Research and Development Ltd. which include some of the methods for data evaluation, adjustment and for derivation of vital parameters. Annex III gives some of the micro computer version of softwares available for data evaluation, adjustment and analysis.

96. An area where methodological developments have not kept pace is that of analysis of socio-economic and household housing especially in respect of computerisation of available methodologies to enable analysts to arrive at meaningful results from available data in a short period of time. ILO prepared a software for projection of labour force and of urban/rural populations. There is need for softwares for projecting school populations, households, families, sub-regional populations etc. This will ensure the fuller integration of population variables in socio economic development planning.

B. Technological Innovations

97. In the evaluation, adjustment and analysis of data, the crucial role of the computer has been alluded to time and again. Thus the advent of the micro computers has revolutionised the data analysis by eliminating some of the routine chores and enabling the analyst to carry out a wider variety of data manipulation at a much shorter time.

(a) Data analysis

98. The computer again has provided a powerful tool to the analyst who with the aid of ready made softwares or custom built programmes can now hope to evaluate and analyse a huge mass of data in greater details of depth and breadth in much shorter time period as well and thereby assist planners and policy makers at local and other sub national levels to effectively integrate population and related data in their decision making and action programmes. However, as with any ready made programmes, there is need for testing and assuring that the results do reflect the socio-economic and demographic realities in the area under study. There is also the need for developing softwares and programmes which will be responsive to the specific demographic, socio-economic data situations in the countries which may not be identical with other developing or developed countries. In other words, blind application of available techniques should be avoided and appropriate methods suitable to the country under study should be aimed at. The role of trained demographers in this endeavour is very important.

99. In the study of population distribution and migration a consistent problem has been the difficulty of preparing maps, charts and diagrams in sufficient details and quantity as to cater to the ever increasing demands of local and small area planners and especially the emerging needs of environmental studies. With the availability of computers and specialised softwares it is now not a difficult task to obtain these useful tools from the raw data. Annex III mentions some of the available softwares in this connection.

(b) Dissemination of information

100. In recent years, a number of important developments have taken place both in technology and user needs and demands for data. As a consequence, the role of statistical offices has changed and there has been need for their reorientation and further streamlining to meet the emerging situations. The developments include availability and increased resort to alternate media for preparing and disseminating data to the users eg. census tapes, computer printouts etc. Further, modern technology has enabled the integration of data processing and printing directly from computer outputs. The use of computers to produce directly the tables and results avoids time consuming tuping, proof reading and correction of manuscripts and materials and assures that no further errors will creep into the data. Another spin off from the use of computers has been the ease with which the tables and reports could be published from computer printouts and the versatility of desktop publishing which in turn has to a large extent, removed the inordinate delays in the publication of census or survey results which used to mar the value of data. However, the quality of output being directly related to the quality of inputs, it is imperative that the inputs be of sufficiently high degree of acceptability and that methods and techniques applied are not only appropriate but are in fact the best under te circumstances and in no way should they introduce other errors and biases.

C. Observations and Conclusions

101. The methodological and technological innovations available to the demographer/analyst has been such as to make his task easier. For example, it is a routine matter to apply some of the demographic evaluation, adjustment and analysis techniques without much knowledge of their strong and weak points. At the same time, it has to be stressed that in order to draw meaningful inferences from data, it is essential that the quality of the information must be good and the techniques and methods are utilised with introspection. This implies that one has to be aware of the effect of defective data on results and conclusions while at the same time being cognizant of the consequences of an indiscriminate application of techniques of evaluation and analysis of data. This calls for a deeper understanding of the methods and the ability to adapt and modify existing methods to suit the conditions on hand. This is a challenge to demographers in the region to face and come up with solutions to the emerging issues. Especially important is the study of the effect of various types and magnitudes of errors and biases in the data observed in African censuses and the adjustment techniques utilised on the estimated vital parameters. Simulation experiments are called for in these exercises.

102. If the demographer/analyst is to be effective he/she should also be familiar with some of the softwares and programmes like word processing, spreadsheet, data base management and in general with the operation of micro computers in order to derive the maximum from these technological aids. It cannot be over emphasized that micro computer use on a vast scale can take place only if demographers and support staff are made sufficiently aware of the benefits to be gained and are familiar with the techniques employed to accept what may generally be considered as an intrusion of a foreign discipline into their accustomed field of speciality.

103. The methodologies and technologies are there and are being continuously honed to suit local conditions. It is for the countries to appreciate them and use them fully in order to optimize the drawing of information and implications from the data and disseminate the findings expeditiously for the use of planners, policy makers and programme managers in social, economic and regional development strategies.

ANNEX T
DATES OF POPULATION CENSUSES IN AFRICA

| Country | Date of previous censuses | Date of next census |
|---|---|---|
| Algeria | April 1966, February 1977, March 1987 | 1997 P |
| Angola | 1950, 1960, December 1970, 1983 | 1993 P |
| Benin | March 1979 | 1990 P |
| Botswana | 1946, 1956, 1964, August 1971, August 1981 | 1991 P |
| Burkina Faso | December 1975, December 1985 | 1991 P |
| Burundi | August 1979 | 1990 P |
| Cameroon | April 1976, April 1987 | 1997 P |
| Cape Verde | 1950, 1960, December 1970, June 1980 | 1990 P |
| Central African Republic | December 1975, December 1988 | 1998 P |
| Chad | ------ | 1991 P |
| Comoros | 1958, September 1966, September 1980 | 1990 P |
| Congo | February 1974, December 1984 | 1994 P |
| Cote d'Ivoire | April 1975, March 1988 | 1998 P |
| Djibouti | 1960/61, January 1983 | 1993 P |
| Egypt | 1882, 1897, 1907, 1917, 1927, 1937, 1947, 1960, 1966, November 1976, November 1986 | 1996 P |
| Equatorial Guinea | 1950, 1960, 1965, July 1983 | 1994 P |
| Ethiopia | May 1984 | 1994 P |
| Gabon | 1960/61, May 1970, August 1980 | 1990 P |
| Gambia | 1901, 1901, 1901, 1911, 1921, 1931, 1963, April 1973, April 1983 | 1993 P |
| Ghana | 1891, 1901, 1911, 1948, 1960, March 1970, March 1984 | 1994 P |

P- Planned date of next census
E- Expected date of next census

DATES OF POPULATION CENSUSES IN AFRICA

| | | |
|---|---|---|
| Guinea | December 1972, February 1983 | 1993 E |
| Guinea Bissau | December 1979, April 1979 | 1990 P |
| Kenya | 1948, 1962, August 1969, August 1979, August 1989 | 1999 E |
| Lesotho | 1875, 1891, 1904, 1911, 1921, 1936, 1946, 1956, April 1966, April 1976, April 1986 | 1996 E |
| Liberia | 1962, February 1974, February 1984 | 1994 E |
| Libya | 1931, 1936, 1954, 1964, July 1973, August 1984 | 1994 E |
| Madagascar | January, April/August 1975 | 1990 P |
| Malawi | 1901, 1911, 1921, 1931, 1945, August 1966, September 1977, September 1987 | 1997 E |
| Mali | December 1976, April 1987 | 1997 E |
| Mauritania | January 1977, April 1988 | 1999 E |
| Mauritius | 1846, 1851, 1861, 1871, 1881, 1901, 1911, 1921, 1931, 1944, 1952, June 1972, July 1983 | 1990 P |
| Morocco | 1960, July 1971, September 1982 | 1992 E |
| Mozambique | 1940, 1950, 1960, September 1970, August 1980 | 1990 P |
| Niger | November 1977, May 1988 | 1999 E |
| Nigeria | 1911, 1921, 1931, 1953, 1963, November 1973 | 1991 P |
| Rwanda | August 1978 | 1991 P |
| Sao Tome & Principe | 1950, 1960, September 1970, August 1981 | 1991 P |

P- Planned date of next census
E- Expected date of next census

DATES OF POPULATION CENSUSES IN AFRICA

| | | |
|---|---|---|
| Senegal | April 1976 May/June 1988 | 1996 P |
| Seychelles | 1931 1871 1971 1947 1960 May 1971 Summer 1977 Summer 1981 | 1987 P |
| Sierra Leone | April 1963 December 1974 December 1985 | 1995 P |
| Somalia | February 1975 November 1985 | 1995 P |
| Sudan | 1955/56 April 1973 February 1983 | 1993 P |
| Swaziland | 1956 1974 1931 1937 1956 1966 1984 May 1986 Summer 1976 Summer 1994 | 1996 P |
| Tanzania, United Rep. of | 1948 1957 1967 Summer 1967 Summer 1978 Summer 1988 | 1998 P |
| Togo | 1958/61 March April 1970 November 1981 | 1991 |
| Tunisia | 1931 1936 1941 1946 1956 1966 May 1966 May 1975 March 1984 | 1994 P |
| Uganda | 1911 1931 1948 1959 Summer 1969 January 1980 | 1990 P |
| Zaire | July 1984 | 1994 P |
| Zambia | 1956 Summer 1969 Summer 1980 | 1990 P |
| Zimbabwe | 1969 May 1982 August 1992 | 1992 P |

P= Planned date of next census
E= Expected date of next census

ANNEX II: Topics canvassed during 1980 round of African censuses (Basic demographic characteristics)

| Topics | Country | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ALG | ANG | BEN | BOT | BVF | BDI | CAM | CVI | CAF | COI | PRC | TVC |
| Census year | '77 | '83 | '79 | '81 | '75 | '79 | '76 | '80 | '75 | '80 | '84 | '75 |
| Relationship to Hd/Hse | X | X | X | X | X | X | X | X | X | X | X | X |
| Marital status | X | X | X | X | X | X | X | X | X | X | X | X |
| Age at marriage | | | | | | | | | | | | |
| Duration of mar | | | | | | | | | | X | | |
| No. of wives | | | | | | | | | | X | | |
| Children ever-born | X | X | | X | | | X | X | X | X | X | |
| Children living/dead | X | X | | X | | | X | X | X | X | X | |
| Most recent birth/ birth last year | | X | | X | | | X | X | X | X | X | |
| Survival of parent/ last birth | | X | | | | | X | X | | X | | |
| Parent survival | | X | | | | | | | | X | | |
| Spouse survival | | | | | | | | | | | | |
| Deaths in hh | | | | X | | | X | | | X | X | |
| Disability | | | | | | | | | | | | |
| physical status | | | | | | | | | | X | | |
| Residence status | X | X | | | X | X | X | | | X | X | X |
| Place of birth | X | X | X | | X | X | X | X | X | X | X | X |
| Ethnic/tribe/ nationality | X | X | X | | | X | X | X | X | X | X | X |
| Citizenship | | | | X | | | | | | | | |
| Place of res. | X | | | | | | | | | | | |
| Usual residence | | | | X | | | X | X | | | | |
| Prev. residence | X | | X | | | | X | | X | | | |
| Dur of residence | X | X | X | | | | X | | X | X | X | |
| Res at specified time in past | X | X | | X | X | | | X | | X | X | |
| Place of work/study | X | | | | | | | | | | | |

E/ECA/PSD.6/TP.6
ANNEX II
Page 2

| Topics | Country | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BUT | BDI | COM | ETH | GAB | GAM | GNB | GUI | GNS | KEN | LBR | LSO |
| Census year | '83 | '78 | '83 | '84 | '80 | '83 | '84 | 83 | '78 | '79 | '86 | '86 |
| Relationship/Sex/Eth. | X | X | X | X | X | X | X | X | X | X | X | X |
| Marital status | X | X | X | X | X | X | | X | X | X | X | X |
| Age at marriage | | | | | | | | | | | | |
| Duration of mar. | X | X | | | | | | | | | | |
| No.of wives | | X | | | | | | | | | | |
| Children ever born | X | X | X | X | X | X | | | | X | X | X |
| Children living/dead | X | X | X | X | X | X | | | | X | X | X |
| Most recent birth/ | | | | | | | | | | | | |
| birth past year | X | | X | X | X | X | | X | | X | X | X |
| Survival of parents/ | | | | | | | | | | | | |
| last birth | X | | X | X | | X | | X | | | X | |
| Parent survival | X | | | | | X | | | | X | | X |
| Spouse survival | | | | | | | | | | | | |
| Deaths in hh | X | | | X | X | | | X | | | X | X |
| Disability: | | | | | | | | | | | | |
| physical status | | X | | X | | | | | | | | |
| Residence status | X | | | X | X | X | X | X | X | | X | X |
| Place of birth | X | X | X | X | X | X | X | X | X | X | X | X |
| Ethnic/tribal | | | | | | | | | | | | |
| nationality | X | X | X | X | X | X | X | X | X | X | X | X |
| Citizenship | | | | | | | | | | | X | X |
| Place of res | X | | | | | X | X | | | | X | |
| Usual residence | X | | X | | | X | X | | | | | |
| Prev. residence | X | | | | | | | | | | X | |
| Dur.of residence | X | X | | X | | | | | | | X | X |
| Res. at specified | | | | | | | | | | | | |
| time in past | X | X | X | | | | | | | X | | |
| Place of work/study | | X | | | | | | | | | | |

| Topics | Country | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LIB | MAG | MAS | MLT | MZM | MAR | MOR | MOZ | NEP | PHL | STP | SAM |
| Census year | '84 | '75 | '77 | '76 | '77 | '83 | '82 | '80 | '77 | '78 | '81 | '76 |
| Relationship/Sex/Age | X | X | X | X | X | X | X | X | X | X | X | X |
| Marital status | X | X | X | X | X | X | X | X | X | X | | X |
| Age at marriage/ | | | | | | | | | | | | |
| Duration of mar. | | | | | | X | | | | | | |
| No.of wives | | | X | | | | | | | | | |
| Children ever born | X | | X | | X | X | X | X | | X | | |
| Children living/dead | X | | X | | X | X | X | X | | X | | |
| Most recent birth/ | | | | | | | | | | | | |
| birth past year | | | X | X | X | X | X | X | | X | X | |
| Survival of recent/ | | | | | | | | | | | | |
| last birth | | | | X | X | X | X | X | | X | | |
| Parent survival | | | X | | | | | | | | | |
| Spouse survival | | | | | | | | | | | | |
| Deaths in HH | X | | X | X | | | | X | | X | X | |
| Disability | | | | | | | | | | | | |
| physical status | X | X | | | | | | | | | | |
| Residence status | X | X | | X | X | | X | X | X | X | | X |
| Place of birth | X | X | X | X | X | | X | | X | X | X | X |
| Ethnic/tribal/ | | | | | | | | | | | | |
| nationality | X | X | X | X | X | | X | X | X | X | X | X |
| Citizenship | | | | | | | | | X | | | |
| Place of res. | | | | | X | | X | X | | | | X |
| Usual residence | | | | | | X | | X | | | | |
| Prev.residence | X | | | | X | | X | | | | | |
| Dur.of residence | X | X | | | X | | X | | X | | | |
| Res. at specified/ | | | | | | | | | | | | |
| time in past | X | | X | | | X | X | X | | | | |
| Place of work/study | | | | | | X | | | | | | |

Topics

Country

| Census year | SEY '77 | SOM '75 | SUD '83 | SWA '76 | WEST '79 | TOG '81 | TUN '75 | UGA '80 | ZAI '84 | ZAM '80 | ZIM '82 | TOT 27 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Relationship/Sex/Age | X | X | X | X | X | X | X | X | X | X | X | 27 |
| Marital status | | X | X | | X | X | X | X | X | X | X | 23 |
| Age at marriage/ Duration of mar. | | | X | | | | X | | | X | | 7 |
| No.of wives | | | | | | | | | | | | 3 |
| Children everborn | X | X | X | X | X | | X | | X | X | X | 23 |
| Children living/mean | | X | X | X | X | | X | | X | X | X | 20 |
| Most recent birth/ birth past year | X | X | X | X | X | X | | | X | X | X | 23 |
| Survival of recent last birth | | | X | X | | | | | | X | X | 20 |
| Parent survival | | | X | X | X | | | | X | | X | 17 |
| Spouse survival | | | | | X | | | | | | | 1 |
| Deaths in hh | | X | | | | X | | | | | | 18 |
| Disability/ physical status | | | | | | X | | | X | X | | 8 |
| Residence status | X | | | X | | X | X | X | X | | | 22 |
| Place of birth | | X | X | X | X | X | X | X | X | X | X | 24 |
| Ethnic/tribe/ nationality | X | | X | X | | X | X | X | X | X | X | 24 |
| Citizenship | | | | | | | | | | X | | 5 |
| Place of res. | X | | | | | | X | | | | | 11 |
| Usual residence | | X | X | | | | | | | | | 11 |
| Prev.residence | | | | | | | X | | | | X | 11 |
| Dur.of residence | | | X | | | | X | | X | X | | 21 |
| Res.at specified time in past | | | | | X | X | X | | | X | | 20 |
| Place of work/study | | | | | | | | | | | | 9 |

# Micro computer software available for data evaluation and analysis

## A. Data evaluation and adjustment

| | | |
|---|---|---|
| 1. ADJAGE | 7. CRUCT | 13. EYEMT |
| 2. AGESX | 8. LOGISTIC | 14. RAKEBIO |
| 3. BEERS | 9. MAPLOT | 15. SPREDSTAT |
| 4. BP5 | 10. MLTE | 16. SMOTH |
| 5. BP10 | 11. MOVEPOP | 17. UNISMH |
| 6. BPSTRG10 | 12. MUHM | |

## B. Mortality analysis

| | | |
|---|---|---|
| 1. BESTPT | 6. LOGITLX | 11. ORPHAN |
| 2. CEBCS | 7. LTABPEAN | 12. PREBC |
| 3. FWDFV | 8. LT-BRTH/STH/UST | 13. SURVI |
| 4. INCHM | 9. MLOGIT | 14. TUOCH |
| 5. LIFTB | 10. QUECH | 15. UNIBR |

## C. Mortality and Fertility analysis

| | | |
|---|---|---|
| 1. ARFE-2 | 6. MARM-MAT | 9. RATE |
| 2. ASFRPATC | 7. MASE | 10. TFR (CEB) |
| 3. FERTCB | 8. RATMORE | 11. TFR (CEP) |
| 4. FERTPF | 9. REPAR | |

## D. Population distribution and Migration analysis

| | | |
|---|---|---|
| 1. ARCINFO | 3. MATTON | |
| 2. MAPINFO | 4. UNTMIG | |

E. Population projections

1. DEMPROJ
2. PEOPLE
3. POPTLO
4. POPPOJ

F Population Models

1. BRAGRGR
2. THISTP
3. PRESTO

# Micro-computer software available for data evaluation and analysis

## A. Data evaluation and adjustment

| | | |
|---|---|---|
| 1. ADJAGE | 7. CENCT | 13. PYRMT |
| 2. ACESX | 8. LOCTSTTC | 14. RAPFACT |
| 3. BEERS | 9. MAPLOT | 15. SEASONAL |
| 4. BP5 | 10. MLPE | 16. SMOTH |
| 5. BP10 | 11. MOVEPOP | 17. WISMW |
| 6. BPSTPRGM | 12. MORM | |

## B. Mortality analysis

| | | |
|---|---|---|
| 1. BESTFT | 6. LOGTRLX | 11. ORPHAN |
| 2. CEBCS | 7. LTABRAN | 12. PERPC |
| 3. FWDPV | 8. LT-NRTH/STH/WST | 13. STRVT |
| 4. INCHM | 9. MLOGIT | 14. TIMCH |
| 5. LIFTB | 10. OMEGA | 15. TRABB |

## C. Nuptiality and fertility analysis

| | | |
|---|---|---|
| 1. ARFE-2 | 6. MARM-MLT | 9. PPLF |
| 2. ASFRPATT | 5. MARF | 10. TFR (CBR) |
| 3. FERTCB | 7. PATMORF | 11. TMR (CBF) |
| 4. FERTPF | 8. RERAP | |

## D. Population distribution and migration analysis

| | |
|---|---|
| 1. ARCINFO | 3. MATTOM |
| 2. MAPINFO | 4. NETMIG |

E. Population projections

1. DEMPROJ
2. PEOPLE
3. PORTLO
4. PORPOJ

F. Population Models

1. BRAGRGB
2. TUSTP
3. BRESTO